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A Two-Dimensional Semantics for Epistemic Modals

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Résumé : Tout le monde ne sait pas que l'eau est du H_2O. Supposons qu'Alice soit l'une de ces personnes. Alice dit : « Pour autant que je sache, l'eau pourrait ne pas être du H_2O. » Intuitivement, il semble qu'Alice ait dit quelque chose de vrai. Autrement dit, il semble qu'il soit épistémiquement possible (pour Alice) que l'eau ne soit pas du H_2O. Pourtant, les conceptions traditionnelles de la modalité en linguistique et en philosophie du langage prédisent que tout énoncé métaphysiquement impossible est également épistémiquement impossible (pour qui que ce soit). Or, il y a des arguments plausibles, venant de Kripke et d'autres, qui prétendent montrer qu'il est métaphysiquement impossible pour l'eau d'être quoi que ce soit d'autre que du H_2O. Selon ces conceptions standards de la modalité, Alice a donc en fait dit quelque chose de faux. Ce résultat est hautement contre-intuitif. Je propose une nouvelle théorie de la modalité qui est capable de représenter ce que j'appelle des IMEPs : des impossibilités métaphysiques épistémiquement possibles. Des phrases comme : « L'eau pourrait ne pas être du H_2O » et « Hesperus pourrait ne pas être Phosphorus » sont des exemples d'IMEPs, et d'autres peuvent être facilement trouvés (y compris certains qui ne reposent pas sur des considérations kripkéennes touchant à la possibilité métaphysique). Ma théorie explique l'existence d'IMEPs tout en conservant la souplesse et la puissance explicative des conceptions standards.

Abstract: Not everyone knows that water is H_2O. Suppose Alice is one of those people. Alice says: "For all I know, water might not be H_2O." Intuitively it seems like Alice has spoken truly. That is, it seems like it is epistemically possible (for Alice) that water is not H_2O. However, conventional accounts of modality in linguistics and philosophy of language predict that any metaphysically impossible statement will also be epistemically impossible (for anyone). And there are plausible arguments, from Kripke and others, that purport to show that it is metaphysically impossible for water to be anything other than H_2O. So according to the standard accounts of modality, Alice has in fact said something false.

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This is highly counterintuitive. I offer a new account of modality that is capable of representing what I call EPMIs: epistemically possible metaphysical impossibilities. Sentences like: "Water might not be H_2O" and "Hesperus might not be Phosphorus" are examples of EPMIs, and others can be readily found (including many that do not rely on Kripkean considerations about metaphysical possibility). My account explains the existence of EPMIs while retaining the versatility and explanatory power of the standard accounts.

1 A motivational example

Alice and Bob are talking about water. They know that water is the clear liquid typically found in lakes and rivers. They know that (pure) water is clear, tasteless, and odorless. However, when asked: "Is water H_2O?," both of them reply "I don't know." Alice says: "For all we know, water might be XYZ." Bob agrees. Given what Alice and Bob know, it seems like Alice has said something true. Alice's statement is an example of an epistemic modal. On the traditional account of epistemic modals, we would say that Alice's sentence expresses the following proposition:

1) $\Diamond_E$(Water is XYZ). [1]

The question arises: how should we interpret the $\Diamond_E$ operator? Standard accounts of modality treat all modal operators as quantifiers over some space of possible worlds. Metaphysical possibility and necessity are standardly represented by quantifying over all possible worlds. [2] Statements of the form $\Diamond_M p$ are true iff there is some world in which p is true; statements of the form $\Box_M p$ are true iff p is true in every possible world. Other kinds of possibility—such as epistemic or deontic possibility—have been analyzed by restricting the space of possibility. For instance, on the standard account of epistemic possibility, the $\Diamond_E$ operator quantifies over only those worlds consistent with our knowledge. That is, we look at all possible worlds when we evaluate metaphysical modals, but only some of the worlds (those consistent with what we know) when we evaluate epistemic modals. The truth conditions for epistemic modals on this kind of view look like this:

- Statements of the form $\Diamond_E p$ are true iff there is some world consistent with our knowledge in which p is true.
- Statements of the form $\Box_E p$ are true iff p is true at all worlds consistent with our knowledge.

1. A note on notation: $\Diamond_E$ indicates epistemic possibility. $\Box_E$ indicates epistemic necessity. $\Diamond_M$ and $\Box_M$ indicate metaphysical possibility and necessity, respectively.

2. Unless otherwise stated, all discussion of possible worlds involves metaphysically possible worlds.

But now we have a problem. Assume for the moment that Kripke and Putnam are correct about the semantics for "water" and other natural kind terms, as described in [Kripke 1980] and [Putnam 1996].[3] On their view, natural kind terms like "water" are rigid designators—that is, terms which denote the same object or class of objects in any possible world. If "water" is a rigid designator and it denotes H_2O in this world, then it denotes H_2O everywhere. Kripke and Putnam argue further that the fact that names and natural kind terms function as rigid designators entails that identity statements of the form "water is H_2O" express necessary truths, because "water" denotes H_2O in all possible worlds, and "H_2O is H_2O" is a necessary truth. This is the necessity of identity, and if we have necessity of identity and "Water is H_2O" is an identity statement, then "Water is H_2O" will express a necessary truth.

I will not detail the arguments advanced in favor of semantic externalism or the arguments for necessity of identity. The main reason for this is that I aim to present an account of epistemic possibility that is consistent with semantic externalism and necessity of identity, and as such will not challenge the central claims of the position. For my purposes, then, the arguments can be assumed to stand. Note, though, that while I do not aim to refute semantic externalism, I am not committed to its being true. Moreover, the problem I identify can arise independently; for instance, in [Johnston 1997], Mark Johnston argues that sentences like: "Water is H_2O" are not identity statements but nonetheless express necessary truths about material constitution.

Given this assumption, the standard account of epistemic modals says that $\Diamond_E$(Water is XYZ) is true if there is an accessible (metaphysically) possible world *w* such that:

1. *w* is consistent with Alice and Bob's knowledge
2. in *w*, water is XYZ.

But Kripke and Putnam's arguments for semantic externalism (and necessity of identity in particular) show that water is necessarily H_2O, and hence we will find that there are no worlds in which water is XYZ. If there are no worlds in which water is XYZ, then we will have to conclude that Alice said something false in saying: "For all we know, water might be XYZ." But we want to say that Alice said something true. Intuitively, then, it seems that Alice's statement expresses an epistemically possible metaphysical impossibility, or an EPMI for short.

Standard accounts of modality (such as those given in [Kratzer 1977] and [Portner 2009]) treat epistemic possibility as a restricted sort of metaphysical possibility and hence predict that there will be no EPMIs. But cases like Alice's suggest this prediction is false. If we want to resolve this problem, it seems clear that we have to say that Alice's sentence doesn't just express 1) above.

3. As we will see this assumption is not required in order to generate the problem under consideration, but it does make it easier to produce examples.

I want to suggest that Alice's sentence is instead associated with a metaproposition, and that it is this metaproposition which is epistemically possible. Intuitively, a metaproposition is supposed to represent something like a Kaplanian character. Sentences with indexicals can express different propositions in different contexts, and the relation between the indexical and its contribution to the proposition expressed is captured by the indexical's character. In the same way, the metaproposition is intended to capture the relation between the world in which a sentence is produced and the proposition it expresses. Formally, metapropositions are functions from a world w in which an expression is produced (the worlds of production) to the propositions expressed by that utterance when produced in w.

On this account, Alice's sentence expresses a truth if there is a world w in which she could utter the same sentence and have it express a proposition which would be true when evaluated in w.[4] It seems reasonable to suppose that there are such worlds. Twin Earth is one of them; as Putnam describes the scenario, "water" picks out something XYZ when used by a Twin Earth native. If this is correct, the sentence: "Water is XYZ" expresses a different proposition when produced on Twin Earth than it does when produced here. In fact, the proposition it expresses when produced on Twin Earth (roughly, that XYZ is XYZ) is a necessary truth. So if the sentence: "Water is XYZ" is produced on Twin Earth, it expresses a proposition which is true when evaluated in Twin Earth, and hence Alice's original sentence ("Water might be XYZ") expresses a truth here on the actual world.

2 The problem with EPMIs

In the preceding section, I used: "Water might be XYZ" as an example of an EPMI. This example relies on certain claims about the semantics of natural kind terms. Kripke and Putnam advance similar claims about the semantics of names, and as a result we can expect the problem of EPMIs to arise for them if Kripke and Putnam are right. Furthermore, we can find examples of EPMIs that do not rely on their (perhaps controversial) semantic claims. One possible example (Johnston's claim that: "Water is H_2O" expresses a necessary truth about material constitution) was given above; there are others.

For example, there are likely to be sentences which are either necessary or impossible and whose truth value is independent of our knowledge. Let us call such sentences unknown non-contingent sentences. Some statements of metaphysical necessity and possibility might be unknown non-contingent sentences. To borrow an example from Quine, consider the sentence: "It is metaphysically possible for something without extension to be colored." If we do not

4. This formulation is missing a few refinements which will be introduced shortly.

know the truth of this sentence, then it is an unknown non-contingent sentence (assuming the truth of the principles of the modal logic S5). If it's false, it is presumably an EPMI.

Sentences regarding *de re* necessary properties of objects can also be unknown non-contingent sentences, if we don't know whether or not the object in question has the property under consideration. For example, suppose that Alice, a painter, is about to display her newest work. No one but Alice has seen the work, which is named "Figure 1." It is known, though, that Figure 1 depicts a plane figure—in fact, it either depicts a square or a circle. We do not know whether Figure 1 is a square or a circle. If Figure 1 is a square, it is necessarily four-sided.[5] And so "Figure 1 is four-sided" is an unknown non-contingent sentence. Suppose there is at least one unknown non-contingent sentence. If that sentence is true, then it is metaphysically necessary but it might well be epistemically contingent. If it is false, then it is metaphysically impossible but it might well be epistemically contingent, in which case it could be an EPMI. In either case, the problem I have outlined in this section for most extant accounts of epistemic modality arises.

Once we have examples of EPMIs in hand, it is fairly easy to see why traditional accounts of epistemic modality cannot adequately account for them. On the traditional account, epistemic possibility is taken to be a restricted sort of metaphysical possibility. That is, if something is metaphysically impossible, it must be epistemically impossible as well. This is because the traditional account takes metaphysical impossibility to be falsehood in all possible worlds and takes epistemic possibility to be truth in some possible world consistent with some knowledge base. If there are no worlds in which a given statement *s* is true, then we will not find any worlds consistent with any given knowledge base in which *s* is true. To resolve this problem, we have to have an account of epistemic modality that takes epistemic possibility to be something other than a restricted sort of metaphysical possibility. The metapropositional account that I offer does just that.

3 The metapropositional account

Many semantic theories index truth to worlds. On such theories, truth is understood as relative to a world. Consider, for example, the sentence: "Grass is green." In ordinary English, this sentence expresses the proposition that grass is green. That proposition is true in some worlds and false in others. We might

5. This claim must be understood as a *de re* modal claim. That is, to claim that Figure 1 is necessarily four-sided is to claim that that very object could not have had three sides. Alice could have created a different painting, and that painting could have been called Figure 1, but it would not have been the very same object.

represent the worlds in which this proposition is true graphically like so:

	w	*u*	*v*
w	T	F	T

In this representation, *w* is our world; *u* and *v* are other worlds. As the table shows, in *u*, grass is not green, but in *v* it is. We could in principle extend the table indefinitely to include all the possible worlds, and having done so we would be in a position to say for any world whether or not grass is green in that world.

Views in which truth is indexed to a single world are one-dimensional views. My proposal is to adopt a version of the two-dimensional semantic framework. In a two-dimensional theory, truth is indexed to pairs of worlds, represented graphically by a two-dimensional array with worlds along both axes. There are many ways of interpreting this array. I offer the following interpretation: expressions are associated with a metaproposition, which is represented by the two-dimensional array. This array encodes information about how the proposition expressed by the expression depends on the world in which the expression is produced; intuitively, it represents something like a Kaplanian character. The worlds of production lie on the vertical axis of the array; the horizontal axis represents the worlds at which the expression is evaluated. Each row of the array thus represents the proposition expressed by the expression when it is produced in the corresponding world.

Consider the sentence: "Grass is green" once again. In our world, this sentence (when uttered in ordinary English) expresses the proposition that grass is green. But we can imagine worlds in which the sentence: "Grass is green" expresses a different proposition because "grass" refers to some other substance. Let us stipulate that *x* and *y* are worlds in which "Grass is green" expresses a different proposition than it does here. We can represent this using a two-dimensional array, like so:

	w	*u*	*v*
w	T	F	T
x	F	F	T
y	F	F	F

This array tells us that, when produced in *x*, the sentence: "Grass is green" expresses a proposition which is true in *y* but false in *w* and *x*. And when it is produced in *y* it expresses a necessary falsehood.

On my view, if I say: "Water might be XYZ," I have said something true if there is a world *w* in which three conditions are met. First, the sentence: "Water is XYZ" has the same basic content [6] in *w* as it does in the actual world. Second,

6. "Basic content" is a technical notion which will be defined in §3.3.

w is consistent with what my audience and I know. Finally, utterances of: "Water is XYZ" express a true proposition when produced in *w*.

3.1 The formal machinery

On my theory, each expression is associated with a metaproposition, which is a function from worlds in which the expression is produced (or worlds of production and abbreviated W_P) to propositions. Propositions are functions from worlds of evaluation (abbreviated W_E) to truth values. W_P includes only those worlds in which expressions have the same basic content (in the sense given later) as they do in the actual world. W_E is the set of all worlds. W_P is thus a subset of W_E. We can represent the metaproposition using a two-dimensional array with the worlds in W_P along the vertical axis and the worlds in W_E along the horizontal. When we adopt this approach, the entire array represents the metaproposition. Each row represents the proposition expressed by the expression when produced in the corresponding world in W_P.[7]

All expressions are evaluated at a pair of worlds (w_1, w_2), where w_1 represents the world of production and w_2 represents the world of evaluation. A sentence *s* is true at (w_1, w_2) iff w_2 verifies *s* when *s* is produced at w_1. We can initially define the modal operators as follows:

- $\Diamond_M s$ is true at (w_1, w_2) when associated with the metaproposition $f(w)$ iff there is some world of evaluation *v* such that $f(w_1)$ is true at *v*.
- $\Diamond_E s$ is true at (w_1, w_2) when associated with the metaproposition $f(w)$ iff there is some world of evaluation *u* such that $f(u)$ is true at *u*.

The necessity operators are defined in the traditional way. That is, $\Box_E s$ is true iff $\neg\Diamond_E\neg s$ is true. The same relationship holds between $\Box_M$ and $\Diamond_M$. Given these truth definitions, we can see that a sentence *s* is metaphysically possible when produced at *w* iff there is some point along the relevant horizontal row at which *s* is true. *s* is epistemically possible iff there is some point along the diagonal at which *s* is true. *s* will be metaphysically necessary when produced at *w* if *s* is true at every point along the relevant horizontal row. Finally, *s* will be epistemically necessary iff *s* is true at every point along the diagonal (subject to a few restrictions, described below).

Again, we can represent this graphically. Consider "Water might be XYZ." Let us stipulate that *w* is our world. *x* is a world that is qualitatively indistinguishable from our world, but it completely lacks H_2O. Wherever H_2O is found in our world, we instead find XYZ in *x*. *y* can be any other world. My claim is that: "Water might be XYZ" is an EPMI, which means that the embedded non-modal

7. A similar application of the two-dimensional framework can be found in Brian Weatherson's [Weatherson 2001]. Weatherson uses the two-dimensional framework to give truth conditions for indicative and subjunctive conditionals. Indicative conditionals have, as he puts it, a "well-known epistemic feel," and the two-dimensional framework is employed in order to capture that feel.

sentence: "Water is XYZ" is epistemically possible but metaphysically impossible. Here is what that will look like:

	w	*u*	*v*
w	F	F	F
x	T	T	T
y	F	F	F

When the sentence: "Water is XYZ" is produced in our world (that is, in *w*), it expresses a necessary falsehood—namely, that H_2O is XYZ. This accounts for the "metaphysically impossible" portion of the EPMI designation. In *x*, the sentence produces a different proposition. When an inhabitant of *x* says: "Water is XYZ," she expresses a necessary truth—that XYZ is XYZ. In particular, the proposition expressed when "Water is XYZ" is uttered in *x* is true when evaluated at *x* (as the center point of the array represents). So, by the definition given above, "Water is XYZ" is epistemically possible.

That said, the truth definitions given above will not quite capture the behavior of actual epistemic modals. To do that we need to recognize two further constraints. First, we have the basic content constraint: W_P includes only those worlds in which expressions retain the same basic content. "Basic content" is a technical notion; I will introduce it in more detail in §3.3. For now, it suffices to say that the basic content of an expression in a given language determines the intension of the expression at every world of production, where intensions are understood in the traditional way as functions from worlds (of evaluation, in this case) to extensions.[8] Holding basic content fixed means we only look at those worlds of production in which the function from world of production to intension is the same as it is here.

The second constraint is that the only worlds we need to examine when evaluating epistemic modals are those that are consistent with what is known. We introduce this constraint to capture the epistemic nature of epistemic modals. We restrict W_P to those worlds consistent with what is known. How is this restriction to be understood? Often, this is done by taking what is known to be a set of propositions, each of which is or determines a set of worlds. The intersection of these sets of worlds is the knowledge base. We will adopt this approach.[9] The claim that knowledge is propositional in this way is

8. The language itself also needs to be held constant. If the morpheme "gap" is used by an English speaker it denotes a gap; in Polish, this morpheme denotes an onlooker. Consider the English modal sentence: "For all I know, the gap between the door and the platform might be six inches across." When we evaluate this modal, "gap" will retain its English meaning. Similarly, we require that the sentence be properly disambiguated. The sentence: "For all I know, that might be a ball" could be about a formal dance or about a round children's toy (among other interpretations). We must disambiguate in order to determine which sense of "ball" is in play and thus which basic content is relevant.

9. For our purposes, all that matters is that the object of knowledge determines a set of worlds. We need not get embroiled in arguments regarding the object of knowledge

consistent with the claim that propositions are not the object of epistemic modal operators.[10] Ultimately, the semantic machinery that I deploy to address epistemic modals does not depend on any particular characterization of knowledge beyond its functional aspect. As long as what is known (whatever it is) determines a set of worlds which can function as a knowledge base, my account should be fine.

With the notions of basic content and the knowledge base in hand, we can revise the truth definition for the epistemic possibility operator like so:

– $\Diamond_E s$ is true at (w_1, w_2) when associated with the metaproposition $f(w)$ iff there is some world of evaluation u such that 1) $f(u)$ is true at u without change in basic content and 2) u is in the knowledge base.

Again, the epistemic necessity operator is defined in the traditional way.

3.1.1 The machinery in action

To see how the proposal developed in the previous subsection functions, I will present two sample cases. For simplicity, the knowledge base will be shared by all members of the conversation in both cases.

Case 1: Where's Carol? Alice and Bob are in Washington, DC wondering where their friend Carol is. Carol is in fact in Zurich, but neither Alice nor Bob know this; in fact, all they know is that she is not in Washington. Alice says to Bob: "Carol might be in Cleveland." On my account, Alice has said something true iff there is a world w such that 1) the English sentence: "Carol is in Cleveland" expresses a proposition which is true when evaluated in w and 2) w is in the knowledge base. The knowledge base in this case consists in those worlds in which Carol is not in Washington.[11] There is indeed

as long as it has this property. If the objects of knowledge are propositions, then that satisfies our requirements. For simplicity I will continue to speak as though the objects of knowledge are propositions and propositions are sets of worlds, but this is not strictly speaking a requirement of the theory.

10. Notice that while this restriction involves the epistemic status of some agent or collection of agents, it does not invoke any preexisting understanding of epistemic possibility. To determine what worlds go in to W_P, we attend to the epistemic status of the relevant agent or agents in a single world—that is, what the agent or agents know about the world they occupy and what further facts are consistent with that knowledge. But this is as it should be, since epistemic possibility and epistemic modality are relative to what is known by the relevant agent or agents.

11. The knowledge base will actually be smaller than indicated here, as Alice and Bob have all sorts of incidental knowledge which is not relevant to the evaluation of the modal sentence. For example, if Bob is wearing a red shirt (and is not red-green colorblind), then he will likely know he is wearing a red shirt. So the knowledge base will include all the worlds in which Carol is not in Washington and Bob is wearing a red shirt. But these other bits of knowledge are irrelevant and so have been glossed over.

such a world: namely, the world in which Carol is in Cleveland. So Alice has said something true.

Case 2: Who's Carol? Alice and Bob have noticed that their mutual friends Carol and Eve are never seen together. Alice has begun to suspect that Carol and Eve might in fact be the same person. She approaches Bob and voices her suspicion, saying: "Carol might be Eve." Here is what Alice and Bob know about Carol: Carol has red hair. Carol is short. Carol works at the bank. Here is what Alice and Bob know about Eve: Eve has red hair. Eve is short. Eve works for the federal government. Eve looks very much like Carol. Let us stipulate that Carol and Eve, despite their similar appearance, are different people. Then (given that identity and distinctness are necessary), it is necessarily false that Carol is Eve. Nonetheless it seems like Alice has said something true, so we seem to have an EPMI.

On my account, in order for Alice to have said something true, there must be a world *w* such that 1) the English sentence: "Carol is Eve" expresses a proposition which is true when evaluated in *w* and 2) *w* is in the knowledge base. This time, the knowledge base will include those worlds in which Alice and Bob 1) have a friend who is a short person with red hair who works at a bank and answers to "Carol," and 2) have a friend who is a short person with red hair who works for the federal government and answers to "Eve." These people need not be distinct. So the world in which the person who answers to "Carol" is also the person who answers to "Eve" is the world in which "Carol is Eve" expresses a true proposition, and hence Alice has said something true.

It is important to note that this world is not a world in which Carol is Eve. Rather, it is a world in which at least one of the names "Carol" and "Eve" denote someone other than Carol and/or Eve and hence the expression: "Carol is Eve" expresses a different proposition, though its basic content is unchanged.

Case 3: Could Carol be a Cylon? Alice and Bob are philosophers. They wonder if their mutual friend Carol has any necessary properties. In particular, they wonder if Carol must be made of matter. Alice says: "For all we know, it might be that Carol might have been an artificial biological life form." Let us stipulate that the outermost modal in this case is epistemic, but the innermost modal is metaphysical. Let us further suppose that Carol must not be an artifical being but Alice and Bob do not know this to be the case. On my theory, Alice has said something true if there is a world of production in the knowledge base in which "Carol might have been an artificial biological life form" expresses a true proposition. Since Carol is not an artificial biological life form, and Alice and Bob know this, we must look for a world *w* in which "Carol" denotes an object which is not an artificial biological life form in *w* but in which "Carol is not a artificial biological lifeform" does not express a necessary truth. Here,

we will run into difficulties. We require "Carol" to have the same basic content in *w* as it does in the actual world. Since "Carol" is a rigid designator in the actual world, it will have to be a rigid designator in *w* as well (though it may not designate the same object in *w* as it does in the actual world). This means that we will not find a world in W_P that has the required properties and that Alice is mistaken in saying that it might be that Carol might have been an artificial being, despite the fact that Alice doesn't know whether or not she might have been an artifical being.

This may seem counterintuitive, but in fact this result is what we should expect. First, it is important to note that one traditional gloss for epistemic possibility is problematic. Traditionally, the statement: "*s* is epistemically possible for some agent *A*" is taken to mean something like: "*A* doesn't know that not-*s*." This rendering entails that *s* is epistemically necessary iff *s* is known. However, epistemic necessity and knowledge have different properties and obtain in different circumstances. For instance, if the epistemic necessity operator is defined as a quantifier over points of evaluation (including worlds in a one-dimensional approach and pairs of worlds for the two-dimensional approach) that uses Kripke models, then epistemic necessity will be closed under entailment [Hintikka 1962]. Knowledge, on the other hand, is not. [12]

Often, the problems involved with identifying knowledge with epistemic necessity are addressed by treating epistemic necessity as an idealization of knowledge—say, as knowledge for ideal reasoners or some such. I have a different strategy. Rather than treat epistemic necessity as an idealization of knowledge, I offer a different (and, I think, superior) intuitive rendering of epistemic necessity. My proposal is to intuitively treat epistemic necessity as follows: *s* is epistemically necessary for *A* iff *s* is known or is entailed by what is known by *A*. *s* is known by *A* if *A* knows the proposition expressed by *s* in the actual world. This entails that *s* is epistemically possible for *A* iff not-*s* is not logically entailed by what *A* knows, or equivalently that *s* is consistent with what *A* knows. [13] One reason to prefer my approach is that it permits us to treat epistemic necessity as an independent object of study with interesting connections to knowledge without requiring us to adopt a rarefied conception of knowledge itself.

Furthermore, my preferred gloss on epistemic possibility is itself a fairly common gloss on epistemic possibility, but the fact that it is not equivalent to the other traditional interpretation given above has not been widely discussed. So there is precedent for adopting my intuitive rendering of epistemic modals. It is

12. I take no position on whether or not knowledge is closed under known entailment or under some other sort of operation. It is clear, though, that knowledge is not closed under entailment *simpliciter* because this would entail logical omniscience.

13. I prefer to define epistemic necessity and possibility relative to knowledge bases, not agents, but I am using agents here to bring out the issues that arise when we associate epistemic necessity with knowledge in the traditional way. A statement can be said to be epistemically necessary relative to an agent if it is epistemically necessary relative to the knowledge base of all worlds compatible with everything that the agent knows.

important to note that this is just an intuitive gloss on epistemic modality, and any formal account may deviate from the intuitive notion at various points. This is to be expected and perhaps even desired. After all, if we had perfectly clear intuitions on epistemic modality we might not need an explicit analysis, and we likely wouldn't find any hard cases where it is unclear whether or not a given expression is epistemically possible or necessary.

Moreover, in investigating our intuitions regarding epistemic modality we might find that they are confused and contradictory; in this case no consistent theory will adequately capture all our intuitions, but we should not want such a theory. My formal account of epistemic modality is intended to stick close to the second, superior intuitive gloss given above, but the theory may not capture the intuitive gloss completely. Cases where the theory and the intuitive notion come apart should be noted but in general, one should not assume that any individual case not covered by the theory should refute it.

When we understand epistemic necessity and possibility in this way, we can see that it is not consistent with Alice's knowledge that Carol might have been an artificial being. Alice knows that Carol is a natural being, and this entails that it is metaphysically necessary that Carol is natural (assuming that Kripkean views of metaphysical necessity are correct). Hence it is epistemically necessary for Alice that Carol is necessarily natural. It is instructive to contrast this with the case in which Alice doesn't know whether or not water is H_2O and says: "For all we know, water might be XYZ." "Water" is still a rigid designator in this scenario, and it is a rigid designator in every world in W_P. However, the crucial difference here is that Alice doesn't know that water is H_2O, and so even though it is metaphysically necessary that water is H_2O, this is not logically entailed by her knowledge. We will see the same result if we consider the case in which Alice doesn't know if Carol is natural or not, and says: "For all we know, Carol might be artificial." It is the nested metaphysical modal that leads to the seemingly counterintuitive result.

In this case, "For all we know, it might be that Carol might have been an artificial biological life form," looks like an EPMI, but it is not. Alice and Bob know that Carol is a natural being, and hence "Carol is a natural being" is epistemically necessary for them given the interpretation of epistemic necessity given above. There is a peculiar feature of the sentence: "Carol is a natural being" that deserves further attention. Given that Carol is a natural being, it follows from the basic content of the sentence that it is metaphysically necessary that Carol is a natural being. Since we hold basic content fixed, there is no way for the sentence to produce a contingent proposition in any world of production (though it could produce a necessarily true proposition or a necessarily false proposition).

There are other counterintuitive cases that warrant some analysis. Consider the following example: "For all Andrew Wiles knew in 1992, Fermat's theorem

might have been false."[14] This might strike us as true, but given the understanding of epistemic necessity and possibility given above (and given certain plausible assumptions about Wiles' knowledge), we should expect this sentence to be false. Fermat's theorem is presumably a necessary truth, and while Wiles did not know that Fermat's theorem was true in 1992, it was likely a consequence of facts that he did know, as Wiles had been working on the proof for years. So we should expect that Fermat's theorem was in fact epistemically necessary for Wiles in 1992.

It might be thought that this interpretation of epistemic necessity and possibility breaks the connection between these technical notions and the English words used to express them, such as "might" and "must." This is not the case. Notice that we intuitively judge the sentence: "Given what Wiles knew in 1992, Fermat's theorem must have been true" to be true, as predicted by my preferred intuitive gloss of epistemic possibility. A natural reading of this sentence is that it is true if Fermat's theorem is a consequence of Wiles's knowledge in 1992. So our intuitions seem to be inconsistent here. Any systematic approach to epistemic modality will thus run into counterintuitive cases. We get similar results with unknown truths of mathematics. It is likely that no one currently knows whether or not the Riemann hypothesis is true. As such, we might think that the Riemann hypothesis and its negation are both epistemically possible for everyone. But this will only be true on one of the two intuitive interpretations of epistemic possibility. On the interpretation I favor, if the Riemann hypothesis is a consequence of what is known, then it is epistemically necessary even though its truth value is unknown. Similarly, if its negation is a consequence of what is known, then it is epistemically impossible even though its truth value is unknown.

3.2 The metapropositional account in context

My theory is in many ways analogous to Kaplan's account of indexicals in [Kaplan 1989]. On Kaplan's account, all utterances occur within a context of utterance and are evaluated with respect to a circumstance of evaluation. This context includes (at least) the speaker, the audience, and the time and place of utterance. Kaplan also maintains that all utterances have a character, which is a function from contexts of utterance to intensions. For many terms, this character returns the same intension regardless of context of utterance. Indexicals are unusual in that they have different intensions in different contexts of utterance; for example, the intension of the word "I" (in its normal use) depends on the identity of the speaker. Given this account, we can take the world in which the utterance was produced to be part of the context of utterance. Names and nat-

14. Andrew Wiles first announced that he had proved Fermat's Last Theorem in 1993. While this version of the proof was flawed, his subsequent attempt in 1995 was successful.

ural kind terms in my account function like indexicals do in Kaplan's account,[15] except they are not (typically) sensitive to the common contextual variations like changes in the speaker's identity, the time of utterance, and so on. Rather, they are sensitive to changes in the world of production. Since we cannot change which world we're in, we can't normally change the index for the world of production, and hence the interpretation of names and natural kind terms does not vary due to variations in the world of production index.

However, when embedded under an epistemic modal, we evaluate the name or natural kind term in the embedded expression as though it was produced in another world. This makes the epistemic "might" and "must" into something like what Kaplan calls monsters (and Evans calls context-shifting operators). Monsters are operators that manipulate one of the indices for the context of utterance rather than the circumstance of evaluation. Most operators are not monstrous; for example, "someday" is a non-monstrous operator. A sentence like: "Someday I will be rich" is true (very roughly) if there is a future time in which I am rich. So in this case, we go looking for a circumstance in which I, Dan Quattrone, am rich, and hence in which the sentence: "I am rich" comes out true when uttered by me. However, note that the indexical "I" in "I am rich" still refers to the original speaker. If I say: "Someday, I will be rich," the sentence will not be true if there is a time in which another person could truly utter the sentence: "I am rich." This is what distinguishes monsters from non-monsters. Monsters affect the index for the context of utterance and in so doing affect the value of indexicals.

Kaplan argues that there are no monsters in English and we could not add any to the language. His argument fails. Kaplan's argument proceeds as follows: if there is any English expression that functions as a monster, it would be an expression like: "In another context. . . " But consider the sentence: "In another context, I am tall." Intuitively, we understand this sentence to be true if there is a context in which I would be judged to be tall. But if "In another context. . . " was truly a monster, then we should expect "In another context, I am tall" to come out true if there is a context containing a tall speaker, who need not be me. That is, most speakers would not judge "In another context, I am tall" to be true because there is a context in which "I am tall" is uttered by Robert Wadlow.[16] We might think that, while "In another context. . . " does not shift the speaker index, it does shift some other feature of the context. I am in fact of roughly average height for an adult male, but I am tall compared to the average height of a child. If I were to say: "In another context, I am tall," we might judge it to be true because "tall" is itself context-sensitive (though it is a gradable

15. Note that this fits well with Putnam's suggestion that natural kind terms have an indexical component. If Putnam is right, that would explain why natural kind terms behave as they do. I am inclined to think Putnam's claim is correct, but nothing here rests on whether or not that is the case.

16. Robert Wadlow is listed in the Guinness Book of World Records as the world's tallest person, measured at 8 feet 11.1 inches just before his death.

adjective rather than an indexical), and because there are contexts in which the relevant height standard is different. However, the shift here is actually part of the circumstance of evaluation. We can see this by considering cases where there is a large gap between context of utterance and circumstance of evaluation. Suppose I record myself saying: "I am tall." We stipulate that the relevant standard for height at the time I initially make the recording is such that I count as tall. Years later, average heights have increased, and with it the standards for tallness. The recording is played in this situation. Intuitively, we would judge my utterance to be false when we hear it. This suggests that "tall" is (at least on some occasions; see below for more discussion) sensitive to features of the circumstance of evaluation rather than features of the context of utterance. So "In another context..." is not a monster. But if "In another context..." is not a monster, then surely nothing else could be.

I agree with Kaplan that "In another context..." and expressions like it are, at least initially, the most plausible candidates for monsterhood in English. I also agree that such expressions are not monstrous. However, it does not follow that there are no monsters in English. First, note that Kaplan's argument is an inductive argument with a very small initial sample, and so needs further support. Second, and more importantly, there is empirical evidence suggesting that English does contain monsters. In [Schlenker 2003] Philippe Schlenker has argued that expressions like: "two days ago" and "in two days" display monstrous behavior, i.e. shift the context index. Consider the following example (a modification of one of Schlenker's examples):

> Bob met Alice exactly one year ago. In two days, she would be dead.

The indexical phrase "in two days" in the second sentence can be heard as referring to two days after Bob met Alice. However, the context of utterance is one year after Bob met Alice. If Kaplan were right and there were no monsters in English, it should be impossible to hear the phrase "in two days" as referring to anything but two days from the time of utterance. Similar phenomena occur when we translate these expressions into French, which lends credence to the notion that these phenomena are not peculiar to English.

Schlenker also shows that the first-person pronoun can function monstrously in other languages. In particular, he shows that the first-person pronoun in Amharic can pick out persons other than the speaker in disquotational contexts, which suggests that the operators that signal disquotation (e.g. "he said") can act as monsters in Amharic. So the Amharic sentence that would be lexically translated as: "Alice said I am hungry" would be better read as: "Alice said she is hungry." This gives us evidence for monsters in other languages, which makes the hypothesis that English has monsters of its own more plausible.

Consider another example: [17]

17. Adapted from examples by Wayne Davis.

> Scenario: There is a picture of Superman hanging on the wall. Lex Luthor comes in and places a placard next to the sign reading: "I am Clark Kent."

In this scenario, Luthor is the person producing the sentence: "I am Clark Kent." If Kaplan is right and there are no monsters in English, then we should expect that the "I" in "I am Clark Kent" to pick out Luthor. But that is not what happens. Instead, we have a case where Luthor can put words in Superman's mouth (as it were), and we hear the "I" as referring to Superman and not to the person who actually produced the expression. This case is unusual in that there is no explicit operator which causes the context index to shift; that said, the indexical is still behaving as though it were governed by a monster, which suggests that such behavior can be observed when there are explicit operators as well.

Finally, let us return to the case of "tall." We have seen that "tall" is sometimes sensitive to features of the circumstances of evaluation rather than the context of utterance. But that does not show that it is entirely insensitive to features of the context of utterance. Consider, for example, the following examples: [18]

1. Had I taken human growth hormone, I would have been tall.
2. Had I lived among the Kalahari Bushmen, I would have been tall.

Both of these sentences seem, intuitively, to be true, but for different reasons. In the first case, the sentence is true using the ordinary standards for tallness. But in the second case, the standards for tallness seem to shift; rather than use the standards for early 21st-century Americans, we adopt the standards appropriate for the Kalahari bushmen. This seems to be monstrous behavior.

Taken together, what these examples show is that while there are English expressions which we would expect to be monsters but are non-monstrous, there are also cases in which English indexicals behave as though they are governed by a monstrous operator. Admittedly, this does not show that epistemic modals are monsters; however, it does show that the hypothesis is not to be dismissed. Moreover, recent work by Paolo Santorio [Santorio 2010] offers direct support for the thesis. Further theoretical support is found in Brian Rabern's [Rabern 2012], wherein he argues (among other things) that Kaplan's own account of demonstratives includes monsters. Given that the hypothesis is consistent with the available evidence and offers considerable explanatory power, we should at least tentatively accept it as (likely to be) true.

3.3 Basic content

One constraint on the theory developed above is that W_P includes only those worlds in which words have the same basic content as they have in the actual

18. Adapted from examples by Steve Kuhn.

world. In this section I will briefly discuss this constraint and present some reasons for thinking it plausible that there is such a thing as basic content in the relevant sense.

Basic content determines an expression's intension at every world of production. We can think of it as a function from worlds of production to intensions, and intensions as functions from worlds of evaluation to extensions. We make use of this concept because we do not want epistemic possibility claims for a metaproposition *p* to depend on what the sentence expressing *p* says in some other language or under unusual linguistic conventions. At the same time, the basic content of a term cannot include the term's extension. On the metapropositional view, the intension of a term (and, *a fortiori* its extension) depends on the world in which it is produced. Since epistemic modals behave like monsters and (effectively) change the index for the world of production, it follows that terms embedded in an epistemic modal can have different extensions than they normally have. Since the basic content of a term is always held fixed (even when embedded in an epistemic modal), and the extension can sometimes vary, basic contents cannot include or be identified with extensions.

This constitutes a break with some semantic externalists, notably Kripke, who argues that the semantic content of a name or natural kind term is exhausted by its reference. My claim is that names and natural kind terms (and, in fact, almost all terms) have some semantic content (where "semantic content" is broadly construed) beyond their reference. Putnam's externalism (at least as described in [Putnam 1996]) is *prima facie* compatible with this notion of basic content, since Putnam allows for semantic contents other than reference.

The notion of basic content is fairly intuitive. In Putnam's original Twin Earth thought experiment, we might notice that if Oscar and his twin switched places, such that Oscar was on Twin Earth and his duplicate was on Earth, neither Oscar nor his twin would have trouble navigating their new worlds. If a Twin Earth native were to say to Oscar: "Please bring me a glass of water," Oscar would be able to satisfy this request, even though he might think he's providing a glass of H_2O. Twin Earth natives interacting with Oscar would judge him a competent user of the language.

However, if Oscar were transported to a world in which "water" denoted gasoline, he might not be so fortunate. Suppose that the world Oscar finds himself on is chemically identical to Earth. However, in this world, "water" denotes gasoline and another word denotes H_2O (and XYZ is nowhere to be found). Call this world Gas Earth. If a Gas Earth native were to say to Oscar: "Please bring me a glass of water," Oscar would not be able to satisfy the request (at least not until he became assimilated to the peculiar linguistic practices of Gas Earth). Oscar's linguistic behaviors will be judged by Gas Earth natives to be incorrect, and Oscar may have the same to say about the linguistic practices on Gas Earth.

The upshot of this is that there are behavioral similarities shared by the linguistic communities on Earth and on Twin Earth, but which neither of them share with the linguistic community on Gas Earth. Basic content is supposed to be the explanation for these behavioral patterns. My suggestion is that the word "water" has the same basic content on Earth as it does on Twin Earth, but not as it does on Gas Earth. Very roughly, I take the basic content of an expression to be those facts that are such that anyone who didn't know them would be judged not to understand the expression. For example, if someone did not know that water is a liquid under normal conditions, we might very well think that they don't know what "water" means, and as such lacks the basic content associated with "water."

This rough characterization might seem to give rise to a problem. Consider sentences like: "Some bachelors might be married" or "Some attorneys might not be lawyers." In both cases, we might envision a situation where someone utters a sentence like this and believes that they have said something true. But on my view, "Some attorneys might not be lawyers" can only express a truth if "attorney" and "lawyer" have different basic contents. But if the basic content of an expression is the facts that we'd say someone needs to know in order to understand the expression, then it seems likely that "attorney" and "lawyer" have the same basic content. Similarly, it seems likely that the basic content of "bachelor" includes the fact that bachelors are unmarried. This issue generalizes, as well; the examples above can be multiplied fairly easily.

But this is only a problem if someone can say: "Some attorneys might not be lawyers" (or whatever example is chosen) and have it actually express a truth. To be sure, the speaker might think they have said something true, and their audience might agree—but that doesn't mean they're right. The only cases I can imagine where the speaker or the audience might judge the sentence to be true are cases where the speaker or the audience doesn't understand the words "lawyer" or "attorney." The same goes for "Some bachelors might be married." In general, I would suggest that these are cases of linguistic confusion and do not weigh against my theory. I would also note that we can be mistaken about whether or not something is epistemically possible, and that mistakes in this arena can come from many different sources. There may be things we do not know we know, for instance, which may constrain our epistemic possibilities. And there may be things we think we know but which are in fact false (and hence not known). It does not seem strange to add linguistic confusions as another source of error here.

4 Chalmers's alternative

There are other approaches to the issue of epistemic possibility that use the two-dimensional framework. The most prominent defender of two-dimensionalism

in this area is David Chalmers, and so this section will focus on his account, developed primarily in [Chalmers 2006].

At the outset, it is important to note that while Chalmers's project does involve epistemic modality, he is also interested in validating what he calls the "Core Thesis." On Chalmers's view, a sentence S has two intensions, called 1-intensions and 2-intensions, respectively. The nature of these intensions will be explained shortly. Chalmers seeks to show that the following is true:

> **Core Thesis:** For any sentence S, S is *a priori* iff S has a necessary 1-intension.

To accomplish this task, he introduces what he calls the epistemic understanding of the two-dimensional semantic framework.

This epistemic understanding leads Chalmers to adopt a different interpretation of the two-dimensional framework:

> The core idea of two-dimensional semantics is that there are two different ways in which the extension of an expression depends on possible states of the world. First, the actual extension of an expression depends on the character of the actual world in which an expression is uttered. Second, the counterfactual extension depends on the character of the counterfactual world in which the expression is evaluated. Corresponding to these two sorts of dependence, expressions correspondingly have two sorts of intensions, associating possible states of the world with extensions in two different ways... [Chalmers 2006]
>
> These two intensions correspond to two different ways of thinking of possibilities. In the first case, one thinks of a possibility as representing a way the actual world might turn out to be: or as it is sometimes put, one *considers a possibility as actual.* In the second case, one acknowledges that the actual world is fixed, and thinks of a possibility as a way the world might have been but is not: or as it is sometimes put, one *considers a possibility as counterfactual.* [Chalmers 2006]

So we have two intensions. Chalmers calls them 1-intensions and 2-intensions. 1-intensions correspond to possibilities considered as actual, and 2-intensions to possibilities considered as counterfactual. [19]

For instance, the sentence: "Water is H_2O" is true in a world considered as counterfactual when H_2O is H_2O. In a world considered as actual, though,

19. Chalmers takes the analysis of the two-dimensional framework in terms of possibilities considered as actual and as counterfactual to be characteristic of two-dimensional theories in general, but this is not obvious. For instance, the metapropositional approach I have developed is best understood in terms of worlds of production and worlds of evaluation. Chalmers is of course free to use possibilities considered as actual or counterfactual as his intuitive starting point even if he's wrong about it being a common starting point among two-dimensional theories.

"Water is H_2O" is true (roughly) when the colorless, tasteless, potable liquid in that world is H_2O. So the 1-intension of "Water is H_2O" assigns the value "true" to all those worlds meeting the latter condition, and the 2-intension assigns the value "true" to all those worlds meeting the former condition (i.e., all of them). Similarly, the 1-intension of "water" maps "water" onto the colorless, etc. liquid in each world, without regard to its chemical properties, while the 2-intension of "water" behaves like we would expect if "water" were a Kripkean rigid designator.

The question arises: why should we think that terms like "water" and sentences like: "Water is H_2O" behave differently when evaluated with respect to possibilities considered as actual than they do when evaluated with respect to possibilities considered as counterfactual? The underlying intuition looks something like this. We know that water is H_2O. But we can imagine that things were different. Dalton, for instance, thought water was HO, in part because his tests could not distinguish between H_2O and HO. Perhaps we're actually in a similar position, and the actual world is not as we believe it to be. In fact, water is XYZ, and our tests are incapable of distinguishing between H_2O and XYZ. If things are actually this way, we do not know that water is H_2O after all, because water isn't H_2O; it's XYZ.

That is, given that water is actually H_2O, it turns out that there is no way things might have been (i.e., no possibility considered as counterfactual) in which water is XYZ. But if the actual world is different than the way we think it is, then perhaps water is not H_2O. And we don't always know which world is the actual world—or at least we don't always know how to distinguish the actual world from similar worlds by description. And even when we can identify a given world *w* as non-actual, we can still consider how things appear to someone who believes that *w* is actual.

Thus far, we have been treating possibilities as worlds, as is traditional (and as we do on my metapropositional account). But this is a bit misleading where Chalmers is concerned, because in [Chalmers 2006] he opts instead to analyze epistemic possibilities in terms of what he calls scenarios. Roughly, according to Chalmers, scenarios are to epistemic possibilities as worlds are to metaphysical possibilities. That is, scenarios are maximal epistemic possibilities situated in a space of all epistemic possibilities, which he calls epistemic space. Chalmers offers up two ways of understanding scenarios. First, he provides an account of scenarios in terms of centered worlds. Centered worlds are ordered pairs consisting in a possible world and a privileged point (called a center). This point specifies a place, time, and an agent in the world and is used to evaluate indexical expressions. Alternatively, he suggests that we can understand scenarios as equivalence classes of infinitary "epistemically complete" sentences in a constructed language L. A sentence S is epistemically complete if it has the following properties:

1. S is epistemically possible. [20]
2. There is no sentence T in L such that S & T and S & ¬T are both epistemically possible.

The language L itself has a limited vocabulary V with the following property:

> Scrutability of Truth: There is a relatively limited vocabulary V such that for any truth S, there is a V-truth D such that D implies S. [21]

We need not concern ourselves with the details of these accounts of scenarios. Chalmers does not definitively adopt either story, and we do not need to do so in order to see how Chalmers's account differs from my own or why we might find Chalmers's account problematic. There are two features shared by both accounts that give rise to difficulties.

First, Chalmers understands scenarios as points in epistemic space. He characterizes epistemic space in terms of *a priori* epistemic possibility. But characterizing epistemic space in this way means that our notion of epistemic space depends on our understanding of epistemic possibility. Indeed, Chalmers is fairly explicit in taking deep epistemic necessity as a primitive (See, for example, [Chalmers 2006, 79]). I take it that part of what it is to offer an analysis of some phenomenon is to offer an explanation for that phenomenon. Ideally this explanation will allow us to understand the phenomenon to be explained in terms of some other phenomena which we already understand. But taking epistemic necessity as a primitive makes it impossible to offer this sort of explanation. Since Chalmers's theory takes epistemic necessity as a primitive, it seems like no matter what other virtues it has, we will not see any improvement on whatever grasp we had on epistemic modality prior to encountering his account. That is, if we're confused about the nature of epistemic necessity (and/or epistemic possibility) before encountering Chalmers's theory, we'll be confused after encountering the view as well. My metapropositional approach does not take epistemic possibility (or epistemic necessity) as a primitive and so it offers up the possibility of a genuine analysis of epistemic modality.

That said, it would be good to have a theory which allows us to determine the truth conditions for an epistemic modal, for instance, even if that theory doesn't explain why any given epistemic modal has its particular truth conditions. Even if Chalmers's account fails as an analysis of epistemic modality, it might succeed at some other worthy tasks. It is worth noting that, whatever Chalmers's goal may be in presenting his account, the fact that it fails as an analysis of epistemic modality makes it less attractive compared to the metapropositional approach I offer. The metapropositional approach, like any theory, has its primitives, but neither epistemic necessity nor epistemic possibility are among them.

20. Note that here, as before, Chalmers takes epistemic possibility as a primitive.
21. Chalmers calls this Scrutability of Truth II; I'm omitting Scrutability of Truth I and leaving off the number to avoid confusion.

The second, and more significant, issue with Chalmers's account has to do with a property he calls "scrutability." Chalmers claims that scenarios are scrutable, and he characterizes scrutability thusly:

> If we come to know that the world has a certain character, we are in a position to conclude that the expression has a certain extension. And if we were to learn that the world has a different character, we would be in a position to conclude the expression has a different extension. That is: we are in a position to come to know the extension of an expression, depending on which epistemic possibility turns out to be actual.

Scrutability is a strong requirement, and it gives rise to problems. Chalmers claims that there are relatively limited vocabularies that allow us to derive (using *a priori* reasoning alone) all the facts about a world from a global description of that world, but there is reason to think this claim is false. While it may be that some worlds can be described in such a way as to make them scrutable, it is not clear that all worlds have this property. Consider the following examples (inspired by [Schroeter 2003]):

Case 1: Mixed Earth Mixed Earth is a world much like Earth. However, while Earth has H_2O, Mixed Earth is a world in which we find both H_2O and XYZ in roughly equal quantities. Lakes, rivers, and oceans are comprised of a mixture of H_2O and XYZ, as are the bodies of Mixed Earth's residents. Mixed Earth's residents can drink H_2O, XYZ, or the mixture of XYZ and H_2O and respond in the same way to all three options.

Case 2: Partitioned Earth Partitioned Earth is also a world in which we find both H_2O and XYZ in roughly equal quantities. However, any given lake, river, or ocean is either entirely H_2O or entirely XYZ. Roughly half of Partitioned Earth's residents have H_2O as part of their makeup; the other half have XYZ. H_2O-people can drink XYZ and vice versa.

Case 3: Coke Earth Coke Earth is a world like Earth. In particular, Coke Earth contains H_2O in all the places that Earth does. However, due to a lucrative marketing arrangement, the people of Coke Earth never imbibe H_2O without mixing it with other chemicals. In fact, they exclusively drink Coke Classic, Cherry Coke, and other soft drinks produced by the Coca-Cola Company.[22] The residents of Coke Earth have in fact been genetically modified to be unable to drink H_2O except when it is found in Coke products.

22. I have received no promotional considerations from Coca-Cola or any other soft drink manufacturers.

In all of these cases, we can ask the same question: what is the referent of the term "water" if these worlds are considered as actual? Chalmers thinks we have fairly clear intuitions about the answer to this question in the case of Twin Earth (and not without reason). But what about Mixed Earth and its cohorts? I, at least, lack clear intuitions about these worlds. First, note that all of these cases appear to be deeply epistemically possible—that is, they all can be considered as actual given what we know *a priori* (though they are all inconsistent with our *a posteriori* knowledge of the actual world). The scrutability requirement applies to all scenarios, and since all deep epistemic possibilities are covered by some scenario or other, we should be able to say what "water" refers to in each case. Let's start with Mixed Earth. When we consider Mixed Earth as actual, we don't seem to have any reason to think "water" refers to H_2O rather than XYZ (assuming it can't refer to both). Perhaps "water" on Mixed Earth functions like "jade" does (or did) in the actual world—but perhaps it doesn't. I, at least, lack strong intuitions one way or the other. And now consider Partitioned Earth. Partitioned Earth has the same kinds of stuff as Mixed Earth, but in different arrangements. Here, too, I lack clear intuitions, excepting the following: it seems less likely to me that "water" functions like "jade" does in the actual world if Partitioned Earth is considered as actual than it does if Mixed Earth is considered as actual. And so it goes for Coke Earth as well; since the liquid found in lakes and rivers is not the drinkable liquid that comes from our taps on Coke Earth, it's not clear which liquid should be the referent of "water."

Here is why cases like these are problematic for Chalmers. Chalmers claims that scenarios are scrutable, which means we can infer (using only *a priori* means) the reference of various expressions from the description of a possibility. Cases like 1-3, though, suggest that there are at least some worlds where this inference is not possibility. Admittedly, cases 1-3 trade on our intuitions (or more precisely our lack of intuitions) about particular cases, and intuition is not the same as *a priori* reasoning. But Chalmers trades on our intuitions as well, using examples like Twin Earth to motivate his scrutability claim. Furthermore, the fact that we lack clear intuitions about cases 1-3 gives us reason to doubt that they are scrutable.

Once we have a few examples like cases 1-3 above, it is easy to produce more. What about the world which is like Coke Earth, except that the inhabitants cannot drink H_2O at all? Or the world in which its inhabitants are surrounded by H_2O but drink XYZ, or vice versa? Again, these cases are not ruled out by our *a priori* knowledge, and so there is a scenario in which these cases obtain. We ought, on Chalmers's view, to be able to consider such possibilities as actual. The ease with which we can construct problematic cases like these suggests that Chalmers can't beat this objection simply by addressing a few individual cases.

Chalmers might try to escape this criticism by claiming that the descriptions given above are insufficiently detailed. Scenarios are, after all, epistemically complete, while the descriptions in cases 1-3 certainly not. This is, I think, an

unsatisfactory response. First of all, cases 1-3 are described in as much detail as Twin Earth, and while it may very well be true that some worlds require more description than others in order to be scrutable this shows that complete descriptions are not always necessary in order to discern the referent of at least some terms. Second, epistemically complete descriptions are inaccessible for actual humans; even if we are to leave aside the fact that they are not expressed or expressible in any natural language, the fact that they are infinitary sentences puts them outside the reach of our cognitive machinery. If scrutability is to mean anything it has to apply to incomplete descriptions of scenarios. Perhaps, with more information, it would be possible to resolve cases 1-3 above—but that doesn't mean that all problematic cases can be handled in this way. Ultimately, I think these considerations show that we would have to accept a large promissory note in order to buy the scrutability claim.

The metapropositional approach presented in §3 does not have to worry about this objection. The basic content constraint and the knowledge base constraint serve to rule out many of the worlds like Mixed Earth and its cohorts. It may be that some cases like 1-3 remain, but as I have not made any claim comparable to Chalmers's scrutability claim their existence is largely unproblematic for my preferred view.

Scrutability also causes other problems. Chalmers's arguments for scrutability involve generalizing from the actual world. But consider alien properties. Alien properties are properties that are uninstantiated in the actual world, but are instantiated elsewhere. For the moment, let us stipulate that there are alien properties.[23] Then there are worlds that instantiate properties that are not instantiated here. And we have no reason to think that such a world could be described using whatever limited vocabulary allows us to produce an epistemically complete description of the actual world.

That said, Chalmers does not say that we can offer an epistemically complete description of every world using some limited vocabulary. His claim, rather, is that every (deep) epistemic possibility (i.e., every scenario) can be so described. But remember that for Chalmers, a sentence is deeply epistemically possible if it's not ruled out by *a priori* reasoning. It seems highly likely that we do not have *a priori* knowledge of precisely which properties are instantiated in the actual world. That is, our *a priori* knowledge does not allow us to specify which properties there are; given a list of all possible properties, we may not be in a position to say which ones are instantiated in the actual world. Consider, for instance, the positions of some ancient Greek philosophers, who thought that all material objects consisted in various amounts of fire, earth, water, and air;

23. The existence of alien properties is controversial, but as we will see nothing in my final argument depends on their existence. They are being used as a way of introducing some unusual epistemic possibilities, and that's it.

it seems odd to say that these philosophers could have realized their error as a result of *a priori* reasoning rather than as a result of empirical science.

The upshot of all this is that whether or not there are alien properties, it is plausible that there are deep epistemic possibilities (i.e., scenarios) that instantiate properties not found in the actual world.[24] And we have no reason to think that these scenarios can be described using whatever limited vocabulary we find that allows us to produce an epistemically complete description of the actual world.

Chalmers's approach, then, has some significant issues stemming mainly from his characterization of scenarios as 1) points in epistemic space and 2) scrutable. Since the metapropositional approach that I favor does not involve epistemic space or have a scrutability requirement, it comes as no surprise that it does not suffer from the same flaws.

Chalmers also offers up a typology of two-dimensional accounts. On his typology, my view would be closest to what he calls a semantic contextual understanding of the two-dimensional framework. Chalmers rejects this understanding (along with all the other understandings) as being incapable of validating the Core Thesis. As I have no particular interest in validating the Core Thesis, I do not find this to be adequate reason to reject my view.

5 Conclusions

The upshot of this paper is this: if you're going to use worlds (or situations) to account for epistemic modality, two-dimensionalism is the most promising extant approach. Since the possible worlds framework has been successful thus far in philosophy and linguistics, I opt for the two-dimensional alternative. My proposed version of the two-dimensional solution to the problem of EPMIs is not the only possible version; in particular, David Chalmers has his own understanding of the two-dimensional framework (put forward, among other places, in [Chalmers 2006]) which differs from my own on several significant issues. I have also given reason to think my view is more promising than his approach. My main purpose here, though, is simply to present the problem of EPMIs and offer a sketch of one two-dimensional solution along with some reasons to think that two-dimensionalism is a promising line of inquiry, and that purpose, has, I think, been fulfilled.

24. These properties, strictly speaking, wouldn't be alien properties, since they might not be instantiated at any world.

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